Module 2 - To Err is Human

ME3023 - Measurements in Mechanical Systems

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Topic 4 - Accuracy and Error

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Thought Experiment

Thought Experiment: Look around the room and choose an object. It can be anything. Ask yourself the following questions.

- What is the **true** length of the object?
- How can you find the **true** value? Can you measure it?
- ...

Image: T.Hill

True and Measured Value

The exact value of a variable is called the true value. The value of the variables as indicated by a measurement system is called the measured value. The accuracy of a measurement refers to the closeness of agreement between the measured value and the true value. But the true value is rarely known *exactly*, and various influences, called errors, have an effect on both of these values. So the concept of the accuracy of a measurement is a *qualitative* one.

$$error = measured\ value - true\ value$$

Text: Theory and Design of Mech. Meas.

Estimating Error

The **true value** can be estimated but cannot not be known *exactly*. In practice a reference value is used in place of the true value. We will discuss this again the the *Calibration Module*.

$$accuracy = \frac{|error|}{reference\ value} \times 100$$

An estimate of error based using this value is sometimes referred to as relative accuracy.

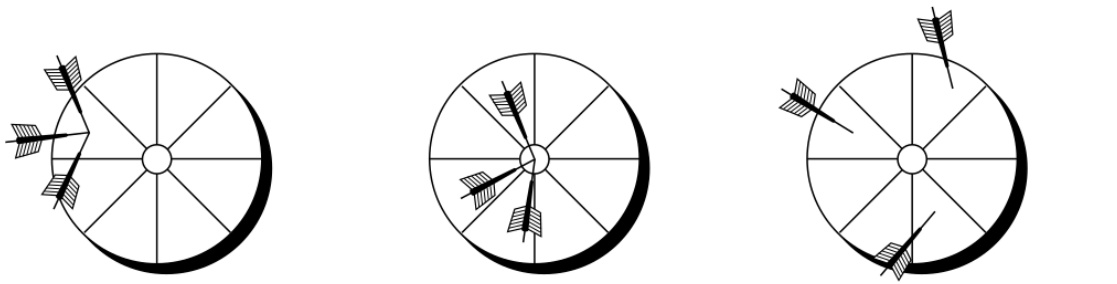
Random and Systematic Errors

"Errors are effects that cause a measured value to differ from its true value. Random error causes a random variation in measured values found during repeated measurements of a variable. Systematic error causes an offset between the mean value of the data set and its true value. Both random and systematic errors affect a systems accuracy."

Text: Theory and Design of Mech. Meas.

Dart Board Example

"The concept of accuracy and the effects of systematic and random errors in instruments and measurement systems can be illustrated by the throw of darts."



(a) High repeatability gives low random error but no direct indication of accuracy.

(b) High accuracy means low random and systematic errors.

(c) Systematic and random errors lead to poor accuracy.

"The ability of a measurement system to indicate the same value on repeated but independent application of the same input provides a measure of the instrument repeatability."

Text, Image: Theory and Design of Mech. Meas.